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Research Article

ROLE OF INORGANIC FERTILIZERS (UREA, SUPERPHOSPHATE AND POTASH) ON BIOMASS PRODUCTION OF *AMARANTHUS PALMERI* WATS

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ABSTRAT
Inorganic fertilizers (urea, potash and super phosphate) were used. Urea shows uniform increasing impact on biomass while potash and superphostate shows different responses which are promotory as well as inhibitory. Relative effectiveness were, superphosphate >urea >potash found in root and shoot biomass of *A. palmeri.*

Key Words: *Amaranthus Palmeri, Inorganic Fertilizers, Pot Culture*

INTRODUCTION
In plant nutrition, besides carbon dioxide and water some other materials are also essential. Among them are: The macronutrients, nitrogen, phosphorus and potassium which are required by the plant in large quantity, (ii) the secondary nutrients calcium, magnesium and sulphur which are required in lesser but still conciderable quantity, (iii) the micronutrients (trace elements) iron, manganese, copper, zinc, boron, molybdenum and chlorine, the requirements, of which are in extremely small quqntity. The role of CO_2, water, micronutrients in plant growth are well known (Kirk-othmer, 1966), but comparatively little information is available on the role of trace elements in plant nutrition. The supply of macronutrients is the primary function of fertilizer industry. The availability of nutrients influence plant growth. It is possible to generalize about the response of plants to limited amount of most nutrients. However, there are species and community specific responses and adaptations that enable plants to cope with specific nutrient limitations. Rajasthan has soil of low fertility. Additional nutrients like urea, potash, superphosphate, NPK and farm-yard manure if supplied to the soil may influence the productivity of plants. The present work is based on the analysis of certain nitrogenous and phosphatic fertilizers for biomass study in pot culture experiment.

MATERIALS AND METHODS
Pot culture experiments were carried out with seeds *Amaranthus palmeri,* which are small and lenticular in shape. The random amount of seeds was used in experiment. Plants were grown under natural environmental conditions in earthen pot of 28×28×16 cm. size. Each pot was filled with seven kilogram of garden soil. The soil was amended with different nutrients, namely, urea, super phosphate and potash in ratio of 0.01 g/kg, 0.02 g/kg 0.03g/kg and 0.05g/kg. For each treatment three replicates were used. A set of pots without any additives served as control. Pots were irrigated manually using watering cans regularly i.e. every day. After every 15 days the data regarding biomass (fresh weight) were recorded up to three and half month (105 days) and statistically analysed. Every 15 days interval was considered as a period. Vegetative growth and flowering and fruiting were observed in treated plants.

RESULTS
Urea
Increasing concentration of urea showed enhancing effect in both roots and shoot growth. The root and shoot biomass gradually increased in the control, as well as in the treated plants. Biomass calculated after every period i.e. 15 days. The initial weight (i.e. 0.04g) of the roots of control plants is least whereas in

the soil amended with 0.05g of urea was just the double (Table 1 and Pl. 1A). In case of shoot biomass urea showed increasing effects where biomass increased less than two times, as compared to control. At the IVth period results showed the maximum increase of biomas according to concentration. Data were found to be statistically significant (Table 2 and Pl 2A).

Superphosphate

Superphosphate shows variable effect. Growth was best in Vth period (except control for root i.e. IVth period) for root and shoot where 9.29 and 7.15 times more fresh weight were found respectively than the initial fresh weight (Table 3 and 4). Data regarding statistical analysis for root and shoot biomass was found highly significant (Pl.1 and 2B).

Table 1: Effect of urea on root biomass (fresh weight) of *A. palmeri* in pot culture experiment.

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.04	0.08	0.15	0.85	1.04	1.52	1.67
0.01 g/kg	0.05	0.15	0.22	0.95	1.10	1.75	1.95
0.02 g/kg	0.05	0.08	0.17	1.52	1.57	2.01	2.10
0.03 g/kg	0.07	0.15	0.26	1.96	2.15	2.60	2.74
0.05 g/kg	0.08	0.16	0.35	1.50	1.75	2.65	2.85

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	8.5676	1.4279	233.55**
Conc. within 0.01 gm/kg	6	10.0775	1.6795	274.89**
Conc. within 0.02 gm/kg	6	14.5683	2.4280	397.38**
Conc. within 0.03 gm/kg	6	24.9467	4.1577	680.48**
Conc. within 0.05 gm/kg	6	22.1634	3.6939	604.56**
Between concentrations	4	6.2191	1.5547	254.45**
Error	70	0.4279	0.0061	-

Table 2: Effect of urea shoot biomass (fresh weight) of *A. palmeri* in pot culture experiment.

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.36	0.66	1.32	6.60	7.95	9.21	9.89
0.01 g/kg	0.43	0.99	1.81	7.00	8.11	9.30	9.90
0.02 g/kg	0.45	0.99	1.83	8.86	9.60	10.40	11.00
0.03 g/kg	0.51	1.05	2.19	11.90	12.39	12.83	13.29
0.05 g/kg	0.69	1.40	2.61	13.30	13.85	14.26	14.55

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	305.3924	50.8987	2.11^{NS}
Conc. within 0.01 gm/kg	6	316.6677	52.7779	2.19 ^{NS}
Conc. within 0.02 gm/kg	6	415.8260	69.3043	2.87*
Conc. within 0.03 gm/kg	6	642.7320	107.1220	4.44**
Conc. within 0.05 gm/kg	6	807.1220	133.7121	5.55**
Between concentrations	4	201.6768	50.4192	2.09^{NS}
Error	70	1686.4022	24.0957	

Potash

In Potash treatments biomass showed negative responses for root, as well as shoot biomass for the studied plant. With increasing in concentrations of Potash fresh weight gradually decreased. Lower concentration of potash (0.01g/kg soil) was found to be more or less equal to control. Maximum increase in biomass among different periods was observed at IV^{th} period for the root, as well as shoot. In both root and shoot, higher concentration had results inferior to the control and the periodically increase in root and shoot fresh weight was 9.29 and 7.15 times respectively more than initial fresh weight at IV^{th} period (Table 5 and 6, Pl.1and 2C). Statistical analysis revealed that data show highly significance except only among concentration for shoot in *A. palmeri*. There was fast increase in the growth of root and shoot up to IV^{th} period in all the treatments and after this growth becomes slow. While comparing root and shoot biomass, shoot biomass was 7-8 times more than root.

Table 3: Effect of superphosphate on root biomass (fresh weight) of *A. palmeri* in pot culture experiments

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.04	0.08	0.15	0.85	1.04	1.52	1.67
0.01 g/kg	0.06	0.12	0.20	0.65	1.21	1.31	1.80
0.02 g/kg	0.06	0.14	0.24	0.67	1.31	1.71	2.10
0.03 g/kg	0.09	0.18	0.37	0.82	1.46	1.64	2.42
0.05 g/kg	0.09	0.19	0.36	1.19	1.98	2.08	3.01

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	8.5707	1.4284	41.68**
Conc. within 0.01 gm/kg	6	8.4353	1.4058	41.02**
Conc. within 0.02 gm/kg	6	7.9962	1.3327	38.88**
Conc. within 0.03 gm/kg	6	15.0174	2.5029	73.03**
Conc. within 0.05 gm/kg	6	22.6486	3.7747	110.13**
Between concentrations	4	4.3097	1.0774	31.43**
Error	70	2.3989	0.0342	

Table 4: Effect of superphosphate on shoot biomass (fresh weight) of *A. palmeri* in pot culture experiments

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.36	0.66	1.32	6.60	7.95	9.21	9.89
0.01 g/kg	0.48	0.93	1.94	4.90	8.95	9.79	10.11
0.02 g/kg	0.49	0.89	1.75	5.81	11.09	11.12	12.22
0.03 g/kg	0.90	1.95	2.58	6.05	11.61	12.01	12.89
0.05 g/kg	0.99	1.99	3.60	9.24	15.62	16.15	17.50

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	305.3924	50.8987	122.17**
Conc. within 0.01 gm/kg	6	341.2850	56.8808	136.51**
Conc. within 0.02 gm/kg	6	519.1240	86.5206	207.65**
Conc. within 0.03 gm/kg	6	499.7833	83.2972	498.35**
Conc. within 0.05 gm/kg	6	930.5520	155.0920	372.26**
Between concentrations	4	249.7588	41.6264	99.88**
Error	**70**	**29.1635**	**0.4166**	

Table 5: Effect of potash on root biomass (fresh weight) of *A. palmeri* in pot culture experiments

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.04	0.08	0.15	0.85	1.04	1.52	1.67
0.01 g/kg	0.04	0.08	0.16	1.47	2.21	2.80	2.91
0.02 g/kg	0.03	0.07	0.15	1.08	2.17	2.78	2.90
0.03 g/kg	0.03	0.07	0.15	1.40	2.10	2.60	2.81
0.05 g/kg	0.02	0.05	0.10	0.56	1.21	1.73	1.97

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	8.5707	1.4284	25.62**
Conc. within 0.01 gm/kg	6	29.3067	4.8844	87.62**
Conc. within 0.02 gm/kg	6	30.0088	5.0014	89.72**
Conc. within 0.03 gm/kg	6	26.7196	4.4532	79.88**
Conc. within 0.05 gm/kg	6	11.1623	1.8603	33.37**
Between concentrations	4	7.3296	1.8324	32.87**
Error	70	3.9019	0.0557	

Table 6: Effect of potash on shoot biomass (fresh weight) of *A. palmeri* in pot culture experiments

Conc.	Biomass (Fresh weight) in gm per plant						
	I	II	III	IV	V	VI	VII
0.00 g/kg	0.36	0.66	1.32	6.60	7.95	9.21	9.89
0.01 g/kg	0.51	1.10	2.00	6.08	10.08	11.00	11.63
0.02 g/kg	0.49	0.86	1.75	5.84	5.93	6.60	7.98
0.03 g/kg	0.41	1.13	1.40	5.18	5.70	6.55	6.88
0.05 g/kg	0.30	0.61	1.33	5.08	5.16	6.55	6.36

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within 0.00g/kg	6	305.3924	50.8987	4.87**
Conc. within 0.01 gm/kg	6	367.8653	61.3108	5.86**
Conc. within 0.02 gm/kg	6	277.4757	46.2459	4.42**
Conc. within 0.03 gm/kg	6	191.0536	31.8422	3.05*
Conc. within 0.05 gm/kg	6	190.7109	31.7851	3.04*
Between concentrations	4	33.0362	8.2590	0.79^{NS}
Error	70	731.2086	10.4458	-

DISCUSSION

Sustainable crop production requires judicial use of inputs such as fertilizers, the use of inorganic fertilizers has drastically declined following the energy crisis, which has immensely affected most of the developing countries (Hauck, 1981). Urea is one of the synthetic organic fertilizers containing 46% of nitrogen. It is readily soluble and leachable when it is first applied to the soil but when it changes to ammonium it is held by clay and humus in the adsorbed forms that is readily available to plants. Under favorable temperature and moisture conditions urea hydrolyses to ammonium carbonate and then to nitrate within less than a week. The synthesis of ammonium carbonate is dependent on the influence of enzymes produced by numerous soil microorganisms.

Sharma (1993) found that urea, thiourea and citric acid have stimulatory effect on sprouting and growth performance in the stem cuttings of *Commiphora wightii* and *Commiphora agallocha*. Ghos and Chattopadhyay (1999) showed effect of foliar application of urea on yield of mango fruits. It was demonstrated that three application of 4% urea resulted in highest fruit yield per tree and maximum fruit weight was recorded from 3% urea. Myers (1998) observed the effect of N-fertilizer on *Amaranthus* species grain yield, yield components and growth and development investigated in three Missouri environments with 5-levels of N-fertilizer and 3 cultivars. Averaged across cultivars and environments, N fertilizer act and top rate of 180 kg/ha produced a yield increase of 42% relative to plots receiving no fertilizer. Although amaranth yield is responsive to N -application, high rates of N fertilizer can negatively affect grain harvest in terms of excessive plant height, increased lodging and delayed crop maturity. Cai and Qian (2003) found that highest yield and best quality of tobacco were obtained by applying 75 kg/ha nitrogen. Inorganic nitrogenous fertilizer could significantly improve the yield and quality of tobacco, compared with organic nitrogenous fertilizer. Study of Zhang *et al.,* (2002) reveals that the strong immobilization of nitrogen by microorganisms was always followed by a net N mineralization, which was mostly favorable for the growth and development of plant and improved the efficiency of plants for nitrogen fertilizer. Increasing concentration of urea showed enhancing effect in both roots and shoot growth. The root and shoot biomass gradually increased in the control, as well as in the treated plants after every period i.e. 15 days. The initial weight (i.e. 0.04g) of the roots of control plants is least whereas in the soil amended with 0.05g /kg of urea was just the double. There was fast increase in the growth of root and shoot (7-8 times) up to IV^{th} period in all the treatments and after this growth becomes slow (Table 1, 2).

Shoot growth of *Agave lechuguilla* monitored by the unfolding of new leaves from the central cone of folded leaves, a non-destructive measure of dry matter productivity for agaves is enhanced by field applications of N and P (Quero and Nobel, 1987 and Nobel *et al.,* 1988). The leaf N level of *Agave lechuguilla* tend to rise with the application level of N, the increase 15% at 500 kg N per hectare whereas the leaf P level was little affected by P applications up to 500 kg per hectare (Nobel *et al.,* 1989).

Zhu *et al.,* (2001) investigated P and Zn interactions in two wheat cultivars (Brookton versus Krichauff) differing in P uptake efficiency. Phosphorus availability significantly affected plant biomass production, but Zn supply had little effect but in smooth pigweed (*Amaranthus hybridus*) increased concentration of phosphorus did not affect the biomass (Bielinski *et al.,* 2003). Studies conducted in Peru on *A. caudatus* indicated that optimum grain yields can be obtained at plant densities of about 450,000 plants per hactare and fertilizer levels of 100N-138P-180K (Sumar-Kalinowsky *et al.,* 1992). The effect of superphosphate on root and shoot biomass for studied plant are presented in Table3, 4. Superphosphate shows variable effect. Growth was best in V^{th} period (except control for root i.e. IV^{th} period) for root and shoot where 9.29 and 7.15 times more fresh weight were found respectively than the initial fresh weight. Results are highly significant (Table 3, 4).

According to Singh and Sharma (1989) potassium is essential for plant growth and is involved in diverse aspects of plant metabolism like, enzyme activation, stomatal regulation, membrane transport, anion neutralization and maintenance of osmotic potential. Webster and Varner (1954) found that potassium is required in the coupling of certain amino acids to form peptides, thus suggesting that potassium is essential in protein synthesis Sharma (1993) studied the effect of different concentrations of various potassium salts (K_2CO_3, KNO_3, KCI and K_2SO_4) on *Commiphora wightii* and *Commiphora agallocha* and concluded that all the potassium salts were stimulatory for the initiation of roots.

Russell (1915) observed that the weight of Mangel roots *(Beta vulgaris)* in the soil containing plentiful potassium was three times more than in the soil where this element was deficient. Similar results have been observed by Scott and Robson (1991). It was emphasized that root weight was enhanced by potassium treatment in subterranean clover *(Trifolium)*. Gupta and Malhotra (1997) concluded that sufficient potassium is needed in biomass productivity and epicuticular wax deposition in *Euphorbia antisyphilitica*. Adequate potassium related maximisation in biomass was recorded in *Euphorbia antisyphilitica* (Johari and Kumar, 1992).

Thorsteinsson and Elisson (1990) also demonstrated reduction in cytokinin levels in the plants of *Lemna gibba* due to low nitrogen and phosphorus levels. Kuiper *et al.*, (1989) using *Plantago major* var. *pleiosperma*, demonstrated that low levels of nitrogen, phosphorus and calcium resulted in reduced concentrations of zeatin and zeatin riboside (cytokinin) in shoots and roots. Reduced nitrogen levels were viewed as being the primary effector of reduced growth. In Potash treatments plant biomass showed negative responses for root, as well as shoot biomass. With increasing in concentrations of Potash fresh weight gradually decreased. Lower concentration of potash (0.01g/kg soil) were found to be more or less

Amaranthus palmeri

Figure 1: Showing the effect of urea, superphosphate and potash on biomass at IIIrd period (Early flowering seen).

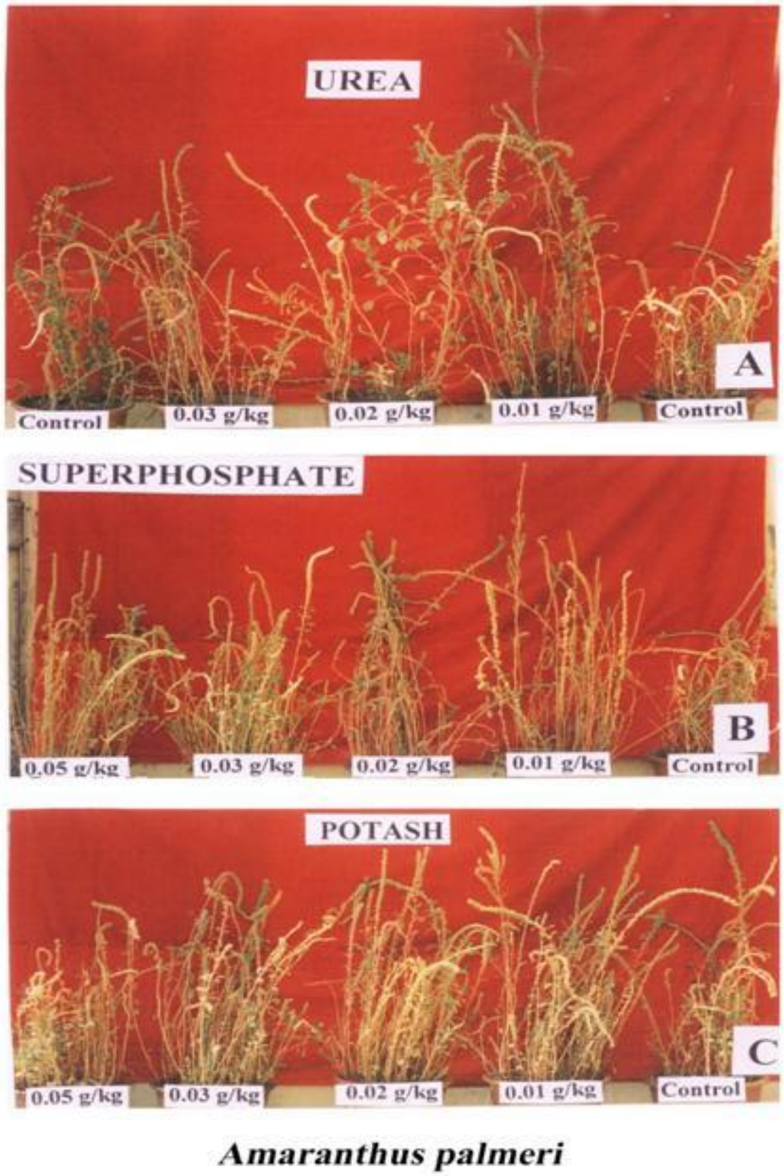

Figure 2: Showing the effect of urea, superphosphate and potash on biomass at VIrd period (Flowering and fruiting seen).

equal to control, Maximum increase in biomass among different periods were observed at IVth period for the root, as well as shoot. In both root and shoot, higher concentration had results inferior to the control and the periodically increase in root and shoot fresh weight was 9.29 and 7.15 times respectively more than initial fresh weight at IVth period (Table 5, 6).

In the present studies it has been found that inorganic fertilizers *viz.* urea, potash and super phosphate were used and among them urea show uniform increasing effect in root and shoot biomass in *Amaranthus palmeri* while potash and superphostate show different responses which are promotory as well as inhibitory. No specific trend has been found using potash and super phosphate while urea shows this.

In general relative effectiveness of used organic and inorganic manure may sequenced as urea > superphosphate > potash were observed in the plants for root as well as shoot fresh weight. Increases in biomass were found in the average range in times comparing to initial fresh weight of 9.29 to 29.06g for root; 6.82-18.73g for shoot of *A. palmeri*. It is found that flowering and fruiting time were changed i.e. September-November to July and August. This may be due to fertilizers or regular irrigation.

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